AN AUTOMATIC DATA PROCESSING CHARGE BACK SYSTEM FOR THE FLEET NUMERICAL OCEANOGRAPHY CENTER

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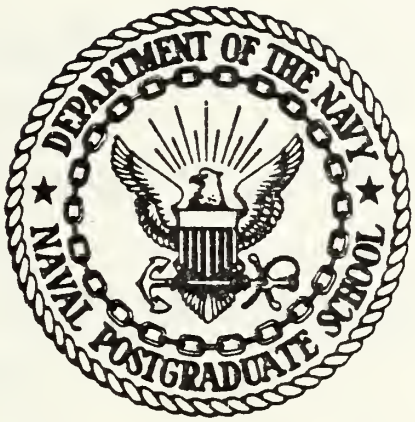

THESIS

AN AUTOMATIC DATA PROCESSING
CHARGE BACK SYSTEM FOR THE
FLEET NUMERICAL OCEANOGRAPHY CENTER

by

Robert P. Leonard

December 1979

Thesis Advisor: J. M. Fremgen

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This thesis develops an automatic data processing charge back system for the Fleet Numerical Oceanography Center (FNOC) in Monterey, California. A brief introduction to FNOC is followed by a review of the current literature on charge back systems, focusing on the goals and principles of charging, types of charge back systems, hard and soft money, and on the resources that should be charged. Navy guidelines on charge back systems for organizations operating under the Resource Management System are reviewed, and reimbursable costs under these guidelines are identified. FNOC's current algorithm for computer service

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by

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This thesis develops an automatic data processing charge back system for the Fleet Numerical Oceanography Center (FNOC) in Monterey, California. A brief introduction to FNOC is followed by a review of the current literature on charge back systems, focusing on the goals and principles of charging, types of charge back systems, hard and soft money, and on the resources that should be charged. Navy guidelines on charge back systems for organizations operating under the Resource Management System are reviewed, and reimbursable costs under these guidelines are identified. FNOC's current algorithm for computer service costs is examined and a new algorithm and rates for billing users are proposed. Possible future directions that charge back may take in the Navy in response to initiatives by the General Accounting Office and the Office of Management and Budget are discussed.

TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

The Fleet Numerical Oceanography Center (FNOC) operates a multi-mainframe computer complex. Its primary mission is to produce every twelve hours a complete weather analysis and prognosis based upon raw climatological, meteorological, and oceanographic data. In addition to this operational function, FNOC's computer resources are used to support the research and development efforts of a myriad of governmental and non-governmental organizations. Additionally, requests for information from FNOC's unique data base are received from commercial firms under the Freedom of Information Act. FNOC currently uses an algorithm (Appendix A) to compute charges for computer use by customers not directly invovled in achieving FNOC's mission. The problem discussed in this thesis is the determination of reimbursable costs and the development of a charging algorithm for FNOC which comply with Department of the Navy guidelines.

To resolve the problem, research of the automatic data processing (ADP) literature was conducted in order to determine alternative approaches to charge back systems recommended by theorists and/or applied in actual practice. Navy guidelines on charge back systems and ADP cost accounting were then reviewed to ascertain what, if any, restrictions are placed upon an individual command's prerogative in the charge back area. With these guidelines in mind, current prices, FNOC on-board strengths and wage rates, historical records, and budget requests were used to estimate the reimbursable costs of running FNOC's computer facility and its utilization for the next year. Employing an algorithm similar to the one already in use, the estimated costs and

utilization were combined to produce a series of rates to charge government and non-government users for resources used under interactive and batch modes.

The following chapter discusses FNOC's mission, hardware, data sources, products, and customers. Chapter III reviews the ADP literature, focusing on the goals and principles of charging, types of charge back systems, and on what resources should be priced. Chapter IV discusses Navy guidelines on charge back systems for organizations operating under the Resource Management System. Chapter V presents the current and proposed algorithms and the underlying costs used to determine rates. Chapter VI discusses possible future directions ADP charge back may take within the Navy in response to initiatives by the General Accounting Office and the Office of Management and Budget. Chapter VII contains a brief summary of the thesis.

II. BACKGROUND OF THE FLEET NUMERICAL OCEANOGRAPHY CENTER

The Fleet Numerical Oceanography Center (FNOC), a major shore activity of the Commander, Naval Oceanography Command,[1]

> is the primary production center of the Naval Weather Service system. It generates basic and applied numerical (computer) products in support of the entire system and from which specific support products are derived. [35:1-1]

FNOC's products consist of meteorological and oceanographic information, produced by the application of sophisticated computer models to raw data. FNOC is located in Monterey, California, and is staffed by 178 military and 88 civilian personnel.

A. MISSION AND FUNCTIONS

The mission of the Fleet Numerical Oceanography Center is:

> to provide, on an operational basis, numerical meteorological and oceanographic products peculiar to the needs of the Department of the Navy; and to develop and test numerical techniques in meteorology and oceanography applicable to Naval Weather Service analytical and forecasting problems. [29:1-2]

Some of the major functions performed by FNOC in carrying out its mission are to:

> (1) Provide operational environmental support to the Commander, Naval Oceanography Command and, as authorized by Oceanographer of the Navy, to other government agencies and/or activities.
>
> (2) Develop operational numerical models and techniques, utilizing all-source (including environmental satellite) data, to provide meteorological and ocean analyses and predictions which are responsive to Navy and DOD requirements as appropriate. Submit reports on TASK/WORK UNIT assignments to cognizant commands via Oceanographer of the Navy.
>
> (3) Maintain atmospheric climatological fields and oceanographic data bank to support numerical analysis and prediction programs.

[1]Until October, 1979, these commands were known as "Fleet Numerical Weather Central" and "Director, Naval Oceanography and Meteorology."

(4) Provide Optimum Track Ship Routing (OTSR) services to Military Sealift Command (MSC), Navy contract ships, and Navy and Allied units in the Pacific on request.

(5) Act as technical advisor to Oceanographer of the Navy for the Naval Environmental Data Network (NEDN) with respect to computer techniques, computer utilization, computer maintenance matters, and allocation of hardware resources.

(6) Act as NEDN system/network coordinator for Oceanographer of the Navy and establish necessary network control procedures to ensure efficient and timely product distribution throughout the network.

(7) Plan, administer and utilize the data from a worldwide oceanographic data-gathering (COOP) program using expendable bathythermograph systems (XBT) on Military Sealift Command (MSC) ships as well as cooperating U. S. and foreign vessels. This includes but is not limited to the following:

(a) Contact ship masters, ship owners and others to obtain launching platforms consistent with available resources and funds and in accordance with stated policy.

(b) Collect, quality-control, digitize, archive and use XBT soundings, and provide the data to other agencies and activities as required and/or directed. [24:1-2]

B. HARDWARE

The computers used at FNOC consist of one Control Data Corporation (CDC) Cyber 170 model 175 (called "SPOCK" by FNOC personnel) and three CDC 6500's (called "Bonnie," "Clyde," and "Hal"). The 6500's have 130k decimal words of core storage; the 175 has 195k. SPOCK also has 100k of extended core storage, while Bonnie and Clyde share an additional 100k of extended core storage. The system has 37 disk drives, providing 22,000k of mass storage in 60 bit words, and 29 tape units. Input devices include cards, terminals, disk, and tape, while output is accomplished on the above devices and also by paper printouts, microfiche, and Varian plotter.

C. SOURCE OF DATA AND PRODUCTS

Raw data making up the data bases are gathered from a multitude of sources, including U. S. Navy and Marine Corps aircraft; Navy, Military Sealift Command,

and commercial ships; Air Force, national, and international meteorological agencies; and the Defense Meteorological Satellite Program. The total number of reports per 12 hour period average 20,000 and are received on three different automated data nets.

FNOC provides to the four Fleet Oceanography Centers (FOC's) computer generated analyses and forecast products, from which the FOC's furnish to operational customers the following regularly scheduled products: Wind Warnings (Oceanic areas), High Sea Warnings, Small Craft Warnings (Harbor), Storm Surge (Tidal) Warnings (Harbor), Fleet Operating Area Forecast, Area Analyses and Prognostic Charts (Meteorological and Oceanographic) Aviation Weather (Air Stations & Routes), Local Severe Weather, and Satellite Cloud Photography. The following specialized support services are also available on request: Nuclear Fallout Warning/Pre-burst Prediction, Optimum Track Ship Routing, Route Weather Forecasts, Ship Helicopter Acoustic Range Prediction Service, Acoustic Sensor Range Predictions, Amphibious Operation Forecasts, Ice Forecasts, and Computerized Search & Rescue (SAR) Planning.

D. CUSTOMERS

Although most of FNOC's customers are operational forces and staffs, due to the unique nature of FNOC's data base, many other Navy, Defense Department, Federal Government, and civilian organizations request access to programs and data. Examples of these organizations include the Naval Oceanographic Research & Development Agency, various Air Force and Coast Guard activities, the National Marine Fisheries Service, and several commercial ocean-routing firms. Additional heavy demand is placed on FNOC's computer resources by those research and development activities (such as the Naval Environmental Prediction Research Facility) which actually develop the forecasting models and software used by FNOC.

III. CHARGE BACK SYSTEMS

With scores of external customers, Fleet Numerical Oceanography Center could be likened to a computer service bureau in the commercial world. The likeness breaks down, however, when the respective motivations for existence are compared. A commercial service bureau is in business to make a profit. FNOC exists to provide a service to operational customers. In view of this role of service, FNOC might better be compared to the ADP Department of a business corporation. Thus, the extensive literature dealing with charge back systems for internal ADP departments can be applied to FNOC's dealings with its external customers (a "charge back" system is simply any of a number of systems which require the user to pay for the computer resources that he consumes).

A. GOALS OF CHARGING

When automatic data processing equipment is first introduced into an organization, the ADP manager's initial role must often be that of a salesman; i.e., he must search for new customers and applications for the service he controls. As the money and labor-saving aspects of computers become evident to other managers in the organization, however, "Parkinson's law of computing" comes into effect:

> ...workload tends to fill available capacity. Experience has shown that without some effective means of control, computer resources have a particularly strong tendency to be used ineffectively and inefficiently, while the demand for computing seems capable of growing without apparent limit. [33:2-3]

With ineffective and inefficient use of computers come rapidly escalating costs (5 and 2).

As the costs of the ADP department rise, corporate management realizes that ADP services are not a free good, but, like all resources, are available in finite quantities and obtained at the sacrifice of other resources. With this realization comes the search for a means to control ADP costs. One of the most common ways is to institute a charge back (also called charge out or fee-for-service) system. Thus, one of the goals of a charging system, recovery of costs, is also a primary means of controlling costs. If users are required to pay for the computer resources they utilize, they will mechanize only those applications which can be done at less expense by computer than manually; that is, when the marginal costs of using the computer is less than the marginal benefit. Additionally, users will be motivated not to be wasteful in their use of computer resources (e.g., not reserving unneeded storage devices [11]), but to be efficient (using optimized programs rather than programs which are less time consuming to write, but also less efficient to run, not requesting interactive processing when batch will suffice, doing away with unneeded reports, etc.).

A second goal of charge back systems can be that of resource allocation among competing users. Unless an organization is in the early stages of computer use (or the organization has just installed a new and larger computer), demand for computing resources typically exceeds the capacity which is available. Although there are organizations which profess to have no allocation policy (that is, every user can submit as many jobs as frequently as he wishes), the truth is that, "if resource allocation is not done explicitly, it will be done implicitly; there is no such thing as 'no allocation'" [12:468]. The most common of these "no allocation" allocation methods is simply that of first-come first-served (FCFS). But delay in turnaround becomes the implicit rationing device - as delays become longer and longer, demand is gradually choked off.

So-called "administrative" rationing is also used. For example, an arbitrary rule may be established so that no job longer than X minutes or requiring more than Y words of memory will be run during the first shift. However, these arbitrary rules do not recognize the value to the user of his individual jobs. Perhaps the job requiring more than X minutes of run time is precisely the one that the customer needs urgently.

By adopting a charge back system and using the normal budgetary process, an activity provides an explicit mechanism for planning and controlling computer usage. That is, the charge back system can act as a rationing device which implements a central decision on the desired distribution of resources.

A third goal of charge back systems could be to affect the utilization of certain particular resources. If, for instance, a computer center were experiencing excessive demand for disk space, it could raise the price for disk in relation to the price of another storage medium, such as tape. Thus, a user concerned with his budget would be motivated to shift some of his use from disk to tape. However, ADP management must recognize that demand for disk was decreased by the internal price, and when procuring new storage, buy the amount of disk which reflects actual user preference.

It should be noted that, when the goal of the charging system is more than just the recovery of costs, there need be no direct relationship between the cost of providing a service and the price charged the user. Price can be based upon the economic demand for the resource: the scarcer the resource, the higher its price.

> If demand for a good is low, its price may well fall below cost, transmitting information to the producer that demand is inadequate. Unless price is permitted to fall below cost, the proper information about demand may never be obtained, and the allocation of resources can never adjust properly to the unprofitability of that good. [14:494]

B. CHARACTERISTICS OF A CHARGE BACK SYSTEM

No matter what type of charge back system is instituted, it should incorporate as many of several widely held principles or characteristics as possible. These characteristics are listed below, with a short description of each.

1. Equity. Charges should reflect resources used - the more resources of a given type, the higher the charges. The resources used should also be under the control of the user. [2:455]

2. Consistency. The same job run on different days, or at different times on the same day should generate comparable charges, regardless of job mix or of which mainframe was used, unless shift differentials or flexible prices are used as a load-leveling device. [27:41]

3. Auditability. Charges should be traceable. [27:41]

4. Ability to Produce Reliable Estimates. The system should allow the user to forecast future costs, not only for budgetary purposes but also to aid in the cost-benefit analysis of new applications. [2:455]

5. Stability. Rates should not change too frequently. Most authors indicate that altering the price of ADP services should be done in conjunction with the adoption of the organization's budget. [27:41]

6. Understandability. The user should be able to understand the charging algorithm if he is to be expected to feel that he has any control over his ADP costs. [27:41]

7. Economy. The cost of the charge back system should be less than the benefit derived therefrom. [27:41]

As is often the case in what appears to be a simple list of characteristics, incorporation of all the theoretically correct features is quite difficult in practice. For instance, the most equitable algorithm contains a factor for

each resource in the computer system; but such an algorithm would be the least understandable to the users. One which is understandable to the customer may not be economical, and so on. The point is that the organization should incorporate those features which most closely reflect its goals.

C. TYPES OF CHARGE BACK SYSTEMS

Just as there are several different goals that charge back systems can attempt to achieve, there are several different types of charge back systems. Although the choice of a type of system is usually made on the basis of considerations other than the desire to achieve a specific goal, it will be shown that certain of the types of charge back systems are appropriate for reaching some goals but not others.

1. Free Good or Indirect Costing Systems

The most elementary approach to charge back systems is not to have one at all. In such an approach, computer resources are treated as a free good; and their costs are not charged to the user but are accumulated in various overhead accounts (hence the term indirect costing system). As indicated earlier, since users do not have to pay for the computer resources that they utilize, they are encouraged to automate some applications which can be performed more economically by a manual system. Once a user gains access to ADP services, he feels that he has a vested right to continue to use these services as long as he wishes. Thus, a user may automate some jobs that will later exclude more deserving applications from automation. Also, "indirect costing results in perpetual saturation, so that management has no guide as to when additional capacity should be installed." [11:521-522] Finally, with an indirect costing system, resource allocation is made by arbitrary administrative rules or by placing pressure on computer operators and ADP management.

2. Average Cost Systems

The most common type of charge back system is the average cost system. [3:6] Under this approach, the total cost of operating the computer facility is divided by the utilization to produce a flat rate which is usually stated as $X per hour. The operating costs and utilization are usually estimated for the next period to produce an approximation of what the true rate should be, although in some organizations the actual costs are used and the rates and charges are determined retroactively.

Part of the reason for the wide use of the average cost charge back system is that the Federal Government, fearful that it may be charged more than its equitable share of computer costs, has mandated its use (or the indirect costing method) for all cost reimbursement type contracts. Universities doing a large amount of research work for the Federal Government have been quick to point out the major drawback of the average cost method. As utilization of the computer increases, the rate to be charged decreases because of the high fixed costs of computer ownership. The decreasing rate may induce users to request more services and thus, to increase turnaround times. A decrease in utilization causes the opposite spiral. Rates go up; usage goes down; and rates go up again the following period. Among university computer centers, this syndrome has forced some difficult decisions. If an unfunded group, such as students, is allowed access to the computer, utilization goes up and rates go down. This decrease in rates results in a decrease in revenue received from the Government and other funded users. Also

> "the cost per unit time of owning and operating a computer is fairly constant over its life and depends only slightly on the amount of work done." [15:B-582]

Because of this fact, it is possible for a customer to use fewer hours of computer time but to have an increase in his charges, if total computer utilization also decreases.

The average cost method of charging can be used successfully to attain the goal of cost recovery. As far as the goal of resource allocation is concerned, the flat rate average cost method allocates resources in a very general way: if a user has no money, he gets no service. But other resource allocation questions such as which jobs should be run on which shift, which jobs should be run first during a shift, and how to treat jobs of different length and desired turnaround time, are left unanswered by the average cost method. Also, the flat rate average cost charge back system, because it is based on the cost of furnishing services, does not provide a mechanism for achieving the third goal of charging systems, that of affecting resource utilization.

When users must pay a flat rate for services regardless of when they are received, there is no economic incentive for users to request services during non-peak shift hours. This may lead to bottlenecks during peak shift, while night and weekend shifts may be under-utilized.

In an attempt to eliminate this peak load problem, some organizations have adopted a variation of the flat rate average cost method by introducing shift differentials; i.e., charging lower rates during non-peak periods. This strategy is usually somewhat successful in smoothing workload between shifts, especially among users of batch processing. The question of which jobs to run first (priorities) is still left unanswered by the average cost charge back system, and all jobs, regardless of length and turnaround time necessary, are charged at the same rate.

3. Flexible Price Charge Back Systems

If ADP resource utilization is the main concern of management, the third main type of charging system, flexible pricing, should be used. Rather than basing user charges on rates determined by costs,

> If some resource is constrained in the amount that can be obtained, then it is priced according to its economic value, not according to its cost. [17:6]

In that way, the different prices charged for different resources can affect their utilization.

Another important aspect of flexible price charge back systems is that they recognize that there is a difference in value among different levels of service (service is usually defined in terms of turnaround time). Because the prices do not have to be based on cost, under flexible pricing systems different prices could be set for several different service levels (e.g., Level I, turnaround of one hour; Level 2, turnaround of three hours, etc.).

If CPU (or any other resource) congestion during particular shifts is a problem, flexible pricing can be used very effectively to help smooth out the peaks. By making the price for CPU use an increasing function of time (e.g., cost for the second five minutes is twice that of the first) during busy shifts and a decreasing function of time during under-utilized shifts, users will have a strong economic motivation to run long jobs during slack periods.

Flexible price charge back systems can be used to satisfy all three possible goals of charge back systems. Their chief drawback is that, because they are more elaborate than other systems, they are more expensive to program, run, and administer.

D. HARD VS SOFT MONEY

Organizations can budget for the allocation of their computer resources in different ways. In some organizations, each budgetary entity is simply given the authority to expend a certain amount of money. This "hard money" may be spent on anything the entity feels is necessary for it to accomplish its assigned functions, including ADP services. Under a hard money system,

entities may or may not be allowed to obtain ADP services from a source other than the organization's own computer facility. Other organizations which require that all ADP services be obtained in-house may use a "soft money" system. Soft money is either a budget allocation that may be spent only on specific services, such as data processing, or some other resource allocation device designed to apportion use of a service among segments of an organization. Soft money may be in the form of a dollar limit on the amount of ADP services that each entity may obtain ("fenced" dollars), or the allocation may be in some other form, such as units of usage (e.g., CPU hours). Whether a hard or soft money system is used, customers must realize that they are paying a price for ADP services and that the "money" to pay for these services is limited.

When the computer is nearly utilized - either totally or on particular shifts - long turnaround times result. In an effort to ensure that the most important work is performed first, priorities are often assigned to jobs, projects or departments. This priority system can be viewed as a soft money system, with the priorities simply serving as a means to allocate scarce resources among competing users. To the extent that priorities are assigned in a uniform manner, there is usually no problem with priority systems. However, if some users get preferential treatment or if priority assignments are not made in accordance with stated policy, the system begins to break down. Also, priority systems will not be effective in allocating resources when demand is so high as to preclude service for all jobs but those having the highest priority.

It should be noted that soft money priority systems are unnecessary under flexible price charge back systems, because the allocation mechanisms are already built into the price schedule. The consensus of opinion in the

literature is that flexible price systems are superior for resource allocation to average cost methods, even if the later is supplemented by a priority system. [3]

E. WHAT TO PRICE

In any data processing organization, there is a large number of resources that could be charged for individually. In balancing the difficulty of accounting for the use of each resource and the need for an equitable charging system against the need to keep the system simple, most organizations select a subset of key resources whose usage forms the basis for billing.

Because the users' attention will be drawn to those resources for which they are charged, these resources must be chosen very carefully. The primary rule in selecting the subset of chargeable resources is that they should contain the "...most heavily utilized resources, i.e., those that impose the main limitation on installation usage." [33:73] For example, in a time-sharing facility, the only bottleneck in usage may be in obtaining a terminal. In that case, charges may only be based upon terminal connect time, with no charge for processor, core, or input/output (I/O) devices.

Not only must the subset of chargeable resources be chosen carefully, but the parameters used to measure these resources can affect user behavior. For example, if I/O time is charged for in terms of total characters, the writer of the program may not be concerned with choosing efficient blocksizes in order to reduce the number of I/O requests required to transfer the data.

A final consideration which must be kept in mind when developing utilization measures is that

> ...the requisite data must be relatively easily obtainable from statistics provided by the operating system, or from other sources such as a hardware monitor, operator console, logs, etc. [33:76]

In an effort to provide users with a simplified bill, some organizations have developed a composite unit which bears such names as Computer Resource Units, Machine Units, and Systems Seconds. These composite units are made up of various mixes of individual resources: CPU time, core memory requested (or used), I/O time, disk used, etc. Although these composite units did simplify the bill,

> ...users did not tend to think in terms of composite units. They still thought in terms of money. That is, they requested so many dollars worth of computing services, not so many computer resource units." [17:7]

A further problem with composite units is that they hide the price of individual resources and thereby reduce the amount of control the user has over his charges.

Rather than charging for resource usage (input), some installations charge for outputs provided. This is most appropriate in administrative applications where the user has no control over how the raw resources are used. For instance, standard accounting transactions could be priced per transaction, and payroll could be charged on a set fee per employee basis. The main advantage of output based charges is that they are stated in parameters that the user can understand and measure. Adoption of this method requires a great deal of effort to estimate the resources that will be required to produce one billable unit. It should be noted that an ADP facility could use an input based charging system for one set of customers and applications and an output related system for another set.

F. PROS AND CONS OF CHARGE BACK SYSTEMS

As a summary of this chapter, arguments for and against the use of charge back systems, many of which have been alluded to previously, will be listed.

1. Pro Arguments

a. Charge back systems promote effective and efficient utilization of computer resources by users (cost control).

b. Charge back systems using hard money force ADP department management to be efficient. If they are not, customers will either obtain services outside the organization or pressure ADP management to provide services at a rate competitive with that of outside sources.

c. Charge back systems provide a conscious and rational method of allocating scarce ADP resources.

d. Charge back systems give a true indication of demand for ADP services and thereby help to prevent the acquisition of unneeded hardware. However, when equipment is fully utilized by paying customers, ADP management is provided economic justification for new procurements.

e. Chargeback systems can be used to improve utilization of specific ADP resources.

2. Con Arguments

a. Administering a charge back system is costly: no increase in real income is received while real costs are incurred.

b. Charge back systems involve arbitrary cost allocations.

c. Charge back systems stifle user innovation and experimentation in new applications.

d. Charge back systems cause excess capacity, since there will be times when users are unable or unwilling to pay processing charges.

The subject of charge back systems is not nearly as controversial now as it was in the late 1960's and early 1970's. The majority of authors and ADP management personnel feel that a well thought-out, carefully implemented charge back system more than pays for itself.

IV. NAVY GUIDELINES APPLICABLE TO CHARGE BACK SYSTEMS

Shore activities are divided by the Comptroller of the Navy (NAVCOMPT) into three classifications based upon the type of accounting system prescribed for use. [23a] These classifications are: industrial-commercial, modified industrial, and nonindustrial. Industrial-commercial activities include shipyards, weapons and ordnance stations, naval air rework facilities, printing service activities, public works centers, all activities and ships under the Military Sealift Command, and research laboratories. Modified industrial activities are naval ship engineering centers and ship repair facilities. All activities not included in the above two categories are nonindustrial activities; therefore, Fleet Numerical Oceanography Center is a nonindustrial activity.

Differences in accounting systems among the classifications can be summarized as shown in Table I. [23]

TABLE I

Type of Activity	Cost Accounting System	Overhead Distribution
Industrial-commercial	Commercial-type system adapted specifically to the activity or type of activity.	Distributes overhead by cost center in such manner as to recover all costs of operation through reimbursement for product.
Modified industrial	Appropriation-type system adapted to accomplish the degree of overhead distribution desired.	Distributes overhead through adjustment of labor charge.
Nonindustrial	Appropriation-type system adapted to account functionally for use of funds.	Does not distribute overhead.

The most important feature as far as this discussion is concerned is that nonindustrial activities cannot distribute and charge customers for their overhead.

Although FNOC receives some money from the Research and Development Appropriation, its main funding source, especially for the operation of its computer center, is the Operations and Maintenance Appropriation. Therefore, its accounting procedures must be in accordance with the tenets of the Resource Management System (RMS) as published in Reference 24.

A. CHARGE BACK UNDER THE RESOURCE MANAGEMENT SYSTEM

> It is the objective of RMS to charge to the performing activity all those costs which are incurred in the performance of its mission even though some part of the mission relates solely to the support of other activities. [23d]

Thus, FNOC supplies the operational and Naval Weather System customers discussed in Chapter II with computer products and services on a no-charge basis, for to do so is part of FNOC's mission.

RMS defines a "reimbursable order" as:

> "a request for work or services to be performed by one responsibility center for another responsibility center, for another Government department, or for a non-federal requester." [24:4-57]

A responsibility center in this context is a command or organization separate from the requesting command. Thus, a request for computer products or services from another organization is a reimbursable order (usually simply called a reimbursable) if it does not fall within FNOC's mission to provide services to the requesting organization.

The RMS handbook further states that the "total costs" of the work performed on the reimbursable job will be billed to the requester of the work. It would seem a simple matter, then to accumulate the "total costs" involved and effect billing to the customer.

As in many cost accounting situations, however, determining exactly what charges are relevant and allowable is much more complicated than it would appear to be on the surface. "Total costs" seems fairly straightforward but, by definition, nonindustrial activities cannot distribute overhead. Therefore, since in this context the term "indirect costs" is synonymous with "overhead," an organization under the RMS can only charge for direct costs. The problem is now one of defining what is meant by "direct costs."

In a paragraph entitled "Special Circumstances in Support Relationships", NAVCOMPT Manual states:

> Provision of ADP services or available but unused ADP resources on a sharing basis, when not within the mission responsibility of the provider, is subject to reimbursement for out-of-pocket costs. Examples of out-of-pocket costs include additional contract maintenance costs due to sharing of Government owned ADP equipment, civilian overtime compensation, and consumable supplies. [23e]

Thus defined, the term "out-of-pocket" costs seems to carry the same meaning as "incremental" or "marginal." This interpretation is reinforced by yet another NAVCOMPT reference which states:

> Ordinarily, when an activity does provide work or services to another activity which is not within its common-service mission, it will charge for such support provided it is significant, identifiable, out-of-pocket, and the costs can be developed without administrative difficulty. When reimbursement for support is valid, the RMS concept requires that the support be measurable. Allocations and prorations of a service are not deemed "measurable" for billing purposes. [23d]

As pointed out in Chapter III the variable costs of a computer facility are relatively low. Thus, if one were to follow the above interpretation of the regulations, the variable, incremental costs which could be charged to a particular customer job would be very low and limited to such consumables as punched cards and paper and, rarely, to any increase in maintenance or labor charges which can be directly traceable to that job.

A case can be made, however, for an interpretation of what can be charged back to users of ADP resources which is much broader than the narrow one outlined above. First of all, in more general applications, a broader interpretation is often found. For instance, it is quite common under cross-service support agreements for allocations of utility costs to be made between the host and tenant sharing a building; the allocation is usually based upon engineering estimates of the relative amount of the utility used by each. A second piece of evidence supporting a broad interpretation of chargeable ADP costs is found in the Chief of Naval Operations Instruction dealing with the "Government-Wide Automatic Data Processing Sharing Program." It states that:

> ADP services provided by an activity on a prolonged and/or repetitive basis should normally be reimbursable through a fair share arrangement. [31:4]

Although the term "fair share" is not defined, it seems to imply that an equitable distribution or allocation of all costs of providing the services should be made.

Thirdly, the latest audit of FNOC by the Naval Audit Service (1977) recommends that, in order to encourage more efficient use of computer resources, users outside FNOC be charged for services "at rates high enough to be economically significant to those users." [30:13] [Clearly, merely paying for computer paper and other consumables would not be "economically significant" to most organizations. At FNOC an average of only 1% of the operating cost of the computer facility is for such consumables.]

B. SUGGESTED CHARGE BACK SYSTEM

The preceding section discussed guidelines for ADP charge back systems issued by the Comptroller of the Navy and by other sources which appear to be in conflict over what can be charged to users. In order to resolve this

conflict, the Head, Budget Policy Branch, NAVCOMPT, was consulted. Admitting that NAVCOMPT's written guidance has not kept up with rapidly changing ADP technology, she advised that NAVCOMPT would support a charge back system which allocated to Federal Government users all costs which were directly associated with the operation of the computer facility: civilian labor up to and including first line supervision, rental of computer equipment, supplies and materials, and maintenance of equipment. Excluded from reimbursement would be utilities, second and higher level supervisors, such general and administrative expenses as supply and comptroller personnel, building maintenance, and depreciation. With respect to depreciation, if equipment is Government owned, its cost must be borne by the purchasing activity; but, if the equipment is leased or rented, its cost can be shared by all users. Civilian labor costs should be accelerated by a locally determined rate to compensate the activity providing the services for leave and other fringe benefits. [24:4-25] For "private parties," that is, non-Federal Government organizations, the above factors plus military salaries are chargeable. To these charges, various additions are made: "4% of direct costs to cover depreciation and interest on investment in DOD-owned fixed assets" [23c], 45% of military officer salaries and 60% of enlisted salaries for fringe benefits [23d], and permanent change-of-station (PCS) travel costs at standard rates "even though a physical PCS move is not caused by the services rendered." [23c and 23d] Finally, "an administrative surcharge of 3% of total costs...to cover general and administrative costs of the DOD component" [23c] is added.

It should be noted that the above system is based upon the cost of providing the service, not upon the value to the customer of receiving the services. It is the opinion of NAVCOMPT counsel (in an undated memorandum) that, pursuant to the Economy Act, 31 USC 686, charges to user activities should

reflect only actual costs incurred. Therefore, neither variable prices nor shift differentials are allowable, because they are based upon the economic value of the services, not the cost of providing them. Thus, the goal of cost recovery can be met by Navy charge back systems; but since an indirect or average cost system (c.f. Chapter III, Section C.2) must be used, the goals of resource allocation and resource utilization (c.f. Chapter III, Section A.2&3) cannot be met.

C. THE NAVY'S ADP CHARGE BACK TEST

The Navy operates several Navy Regional Data Automation Centers (NARDAC's), formerly called Data Processing Service Centers (DPSC's), which are quite similar in function to commercial service bureaus. They had been furnishing ADP support on a no-charge basis, but the Office of the Chief of Naval Operations (OP-91), at that time the organization responsible for the Navy's ADP program, a function now handled by the Naval Data Automation Command (NAVDAC), stated:

> The performance and economic benefits attainable from a DPSC are not likely to be realized if its services are furnished free of charge. The center should be operated on a fully reimbursable basis. Total costs of operating the center (salaries, equipment rentals, supplies, etc.) should be reflected in a billing and accounting system which permits customers to be billed promptly for fair and accurate costs of all services received. This procedure will allow all ADP support costs to be related directly to both the customer activity and the function supported. [34:1]

In order to obtain the maximum "performance and economic benefits," an ADP charge back test was instituted in April 1978 at NARDAC San Diego. During this initial phase, statistics were gathered on usage of NARDAC's resources by its customers. At the beginning of the second phase, scheduled to commence 1 October 1979, the money which would have been granted to NARDAC for operation of its computer facility was divided among its customers on the basis of the

utilization statistics gathered during the first phase. Its customers will now provide reimbursable funding in support of their ADP requirements.

The ADP charge back concept used in the test at NARDAC San Diego differs from the suggested charge back system discussed above in two important respects. First of all, permission to deviate from the RMS was granted by NAVCOMPT so that indirect (overhead) costs could be passed on to customers. However, three overhead items - administration, electricity, and maintenance of real property - will not be passed on to customers. Thus, customers are paying their share of the full costs of the ADP services they obtain, except for the three items mentioned above. Second, and most important, is the fact that the charge back test algorithm contains a "feature which allows NARDAC to charge premiums or grant discounts based on the customer's job priority and shift during which the job is run." [34:20] These premiums and discounts are based on a "run category adjustment table," which is a matrix of percentages of full cost incorporating both requested turnaround time and the requested shift. This is, of course, flexible pricing, as the application of the percentages results in several different prices and allows the customer to weigh the importance of his job against the amount of money he is willing to pay. Unfortunately, because of the legal opinion of the NAVCOMPT counsel mentioned in the preceding section, all percentage values in the matrix will be set at 100, resulting in a single charge. Thus, the most important feature of the charge back test is nullified by current regulations.

V. SPECIFIC CHARGE BACK SYSTEMS FOR FLEET NUMERICAL OCEANOGRAPHY CENTER

A. PRESENT CHARGE BACK SYSTEM

The algorithm currently used for charging for the use of Fleet Numerical Oceanography Center's computer resources is contained in Reference 26 and is shown in Appendix A. Several characteristics of the algorithm are worthy of note. First, the charges are based not only upon the type of service used ("Intercom," i.e., on line, or "Batch") and the model of computer (CDC 175 or 6500) used, but also upon the nature of the user. A "Fair Share" rate, designed to recover the incremental costs of each job plus a portion of the computer center's fixed costs, is applied to most governmental users. An exception is made for those government organizations using the computer

> "for research, development, test and evaluation (RDT&E) of software or data base files which will ultimately be used in the FLENUMWEACEN system." [26:1]

These RDT&E users are charged a lower "Preferred Rate," which is arbitrarily set at 10% of the Fair Share rate in order to reduce the charges to this class of users. The third rate is the "Non-Governmental" rate which is supposed to be charged all non-Federal Government activities which are not performing work under Navy contracts. This rate is theoretically applicable if a contractor should exceed the amount of computer time granted in its contract as Government Furnished Equipment. As a matter of fact, however, it is not actually charged.

Another important characteristic of the current algorithm is the fact that the total cost incurred is made up of as many as eight factors but that six of the factors are used to charge for the use of input/output devices. A seventh factor assesses a charge based upon the user's priority. "Access Level" in the Intercom mode and "job card priority" in the Batch mode are both

cardinal series variables assigned by FNOC to users based upon the importance to FNOC of the work the users are performing. Access Levels vary from 1 to 7, while job card priorities range from 1 to 8, with a higher number denoting a more important priority. In current practice, however, the computer software does not actually record usage by user priority; therefore, the user's bill is not affected by the priority used. Additionally, due to software deficiencies, Intercom use is not reported separately from Batch use; therefore, all usage is billed at the Batch rate.

The eighth factor charges for use of the computer mainframe and contains the variable "SH," which stands for "systems hour." The systems hour is a factor automatically accumulated and reported by the operating system for each job run. It is defined as: SH=CP(1)+IO(1)+CM(.0610)+EC(.0305), where

SH = systems hours
CP = central processor time
IO = input/output channel time
CM = core memory time (kilo/word hours)
EC = extended core memory time (kilo/word hours)

The weighting factors used are those recommended by CDC for initial use by all CDC customers, but they may be altered if the user feels that different factors would be advantageous for cost recovery or resource allocation purposes because of circumstances unique to that organization.

To arrive at the rates to be applied by the algorithm for mainframe use, an estimate of the total number of systems hours that the computer is expected to be used for the next twelve months is made. Costs of running the computer center - including depreciation of computer and peripheral equipment, equipment maintenance, consumables, military and civilian salaries, electricity, air conditioning, and amortization of software - are also estimated. The rate for each system hour is the estimated cost divided by the estimated usage. Charges for the use of the peripheral devices are determined in one of two ways. The

first way (such as "E" = one dollar for each tape mounted) is merely to set an arbitrary rate. The second method is to take into consideration the cost of the equipment plus the cost of the consumable supplies used in that I/O function (e.g., "A," the cost for printing one line, was determined by adding the annual cost of the printers to the cost for ribbons and paper and dividing the sum by the average number of lines printed).

B. STRENGTHS AND WEAKNESSES OF THE CURRENT CHARGING SYSTEM

The principal weakness of the current charging system is not in the algorithm but rather in the costs used to calculate the rates per systems hour. Included in the total cost of running the computer facility are costs for items which, under current regulations, must be excluded from charges to customers. The largest of these costs is depreciation of equipment owned by FNOC; over $4,500,000 in annual depreciation costs are included in the present charging system. Other unauthorized costs include utilities, amortization of software, and military labor costs (when work is done for Federal users).

The current algorithm also contains a feature not authorized by Navy directives. The algorithm contains a factor to charge the user for the priority he uses. Since this charge is not based upon a difference in cost for providing service at each priority, the difference in price is not authorized. For the same reason (i.e., no difference in cost for providing the service) the "Fair Share" and "Preferred Rate" should be a single rate applicable to all Federal Government users.

The algorithm can also be criticized on theoretical grounds. It is an average cost charge back system. Therefore, as discussed in Chapter III, it does not provide a mechanism to allocate resources efficiently and effect resource utilization. Also, since utilization of FNOC's computers is increasing,

the rate charged per systems hour is decreasing; this could result in saturation of FNOC's computing resources.

Another criticism of the current algorithm is that it contains many factors, making it difficult for the user to estimate and control their charges. But at the same time, user charges are also stated in terms of systems hours, which are composite units. Composite units have been criticized for masking the price of individual resources and thus further reducing the control the user has over his charges.

The present charging system also has its strong points. It uses data collected by the computer software and is, therefore, inexpensive to operate. The users, most of whom are quite sophisticated in computer systems, are accustomed to it and have not complained that it is too complicated. Finally, rates have been stable; and the algorithm produces charges which are equitable and consistent.

C. PROPOSED CHARGE BACK SYSTEM AND ALGORITHM

The proposed charge back system was designed to eliminate as many of the above problems as possible without introducing any new problems. The composite unit, systems hours, was retained despite the criticism that composite units mask the price of individual resources. FNOC's customers are quite sophisticated in their knowledge of ADP systems, and the derivation of the systems hour (shown above) is widely disseminated and not particularly complicated. Therefore, the relative cost of the resources making up the systems hour should be understood by FNOC's customers. Eliminating the systems hour would necessitate considerable alteration to FNOC's computer software and cost accounting system without producing any significant benefits.

1. Estimated Systems Hours

Because the CDC 175 computer is faster and more expensive to buy or lease than the 6500's, the charge per systems hour for the use of the 175 should be more than that for the 6500's. In theory, the different rates for the two computer models could be determined by accumulating the costs for each model separately and dividing each model's costs by an estimate of the usage of that model. In practice, however, this method of determining the rates presents a problem. Many of the resources of the computer center are shared by the two computer models, and an allocation of a portion of their costs to each model would have to be made by an estimate of the benefit that each model gets from the shared resources. Since the computer software does not record how much time that, for instance, a tape or disk drive spends under the control of one computer or the other, the estimate of benefit would be extremely hard to make with any precision. Likewise, FNOC does not keep summary records of computer maintenance broken down by model, so an arbitrary estimate would also have to be made to allocate maintenance costs.

To avoid the problem of inaccurate and arbitrary allocation of costs between the two models of computers, a second method for determining the different rates was developed. First a systems hour on the 175 was equated to a systems hour on the slower 6500's. As was shown earlier, a systems hour is computed by the formula SH = CP(1)+IO(1)+CM(.0610)+EC(.0305). Specifications for the two computers shows that the 175's CP is twelve times faster than that of the 6500's; the 175's IO, CM, and EC are all twice as fast as the 6500's. Therefore, a systems hour on the 175 is equal to CP(1)(12)+IO(1)(2)+CM(.0610)(2)+EC(.0305)(2) systems hours on the 6500's.

Second, an estimate was made of the number of systems hours that each model would be utilized during the next year. The estimate was based upon

historical usage data contained in the "MONTHSUM" report and a projection that usage of the 6500's would be, on the average, the same as it had been for the past year, and that usage of the 175 would increase to a level somewhat higher than that experienced since direct satellite processing was begun in August 1969.

The third step in developing rates was to convert the estimate of systems hours on the 175 to their equivalent in 6500 systems hours. This was done by applying the estimate obtained in step 2 to the formula derived in step 1. This computation shows that one systems hours on the 175 is equal to approximately three systems hours on the 6500 (see Table II).

TABLE II

Projected usage of the CDC 175 for the next 12 months is as follows:

SH:	5,274
CP:	412
IO:	232
CM:	31,345
EC:	89,513

Entering the above variables into the equivalency formula gives:

SH (on the 6500) = 412(1)(12) + 232(1)(2) + 31,345(.0610)(2) + 89,513(.0305)(2)

SH = 14,692

Therefore, 5,274 SH on the 175 = 14,692 SH on the 6500, or 1 SH on the 175 = 2.786, or approximately 3 SH on the 6500

The final step is to divide the total chargeable costs of the computer facility by the total systems hours stated in terms of systems hours on the 6500's. The quotient is the rate per hour on the 6500's; the quotient multiplied by 3 is the rate per hour on the 175.

2. Chargeable Costs to Government Customers for Batch Usage

Costs which can be charged to customers on the basis of their usage of systems hours include labor, maintenance of computer equipment, and leases directly chargeable to the computer facility.

a. Labor

FNOC employs only six civilian computer operators. Their salaries (current employees' grades and steps at 1 October 1979 pay rate) plus the FNOC acceleration factor of 29% totals $92,029.

b. Maintenance

Maintenance of the computer equipment is done by FNOC Civil Service employees. Ceiling points exist for 14 employees; however, an average on board count of 12 was assumed because of high turnover. Salaries and fringes under this assumption, plus $10,500 budgeted for overtime, equals $270,777. The fiscal year 1980 (FY 80) budget also calls for $176,000 in parts, and an estimated $17,340 will be used for consumables. The result is a grand total for maintenance of $464,117.

c. Leases

The majority of FNOC's equipment is owned rather than leased; therefore, the total of this category is much less than might be expected for a facility the size of FNOC. The lease costs were taken from the FY 80 budget submission and two important assumptions were made. The first was to include the sophisticated communications equipment in the chargeable costs. Although not computer equipment in the strictest sense of the word, the communications equipment is a direct charge to the computer facility. Without it much of FNOC's data, such as that from satellites, could not be processed.

The second assumption concerned what portion of the lease costs to include as chargeable costs. FNOC plans eventually to buy much of the

equipment it now leases. Under the lease agreement, as much as 70% of the lease payments can be applied to the purchase price should the equipment be purchased at a later date. Therefore, a case could be made for considering only 30% of the lease costs to be reimbursable, since in the long run the lesser amount is the cost to the government. However, 100% of the lease costs is the amount which FNOC must pay each year in order to provide its customers with the service they request. Plans change, and not all of the equipment that FNOC currently plans to purchase will be acquired. Therefore, 100% of the lease costs were included in the costs which are charged to FNOC's customers. These costs total $651,600 for FY 80.

Total estimated chargeable costs for providing batch ADP services to Government customers in FY 80 is $1,207,746. Total estimated systems hours are 302,304 in 6500-equivalent hours. Therefore, a customer using a systems hour on the 6500's should be charged $4.00 ($1,207,746 ÷ 302,304); a systems hour on the 175 should be billed at a rate of $12.00 ($4.00 x 3).

3. Chargeable Costs to Non-Government Customers for Batch Usage

In addition to the costs discussed above, military labor costs are chargeable to non-government users. "Composite Standard Military Rate Tables" are published annually in a NAVCOMPT Notice and in the NAVCOMPT Manual. These composite rates are to be used when costing military labor. As of the date of this writing, the rates for FY 80 had not yet been promulgated. Therefore, they were estimated on the basis of the 1 October 1979 pay raise and the FY 79 composite rates. Military labor costs totaling $1,046,798 were computed by using this estimated composite rate, accelerated by the proper percentages, and adding PCS costs (c.f. Chapter IV, Section B). It should be noted that the authorized (not on board) complement was used, since the person filling a billet may be rated from one grade above to one grade below that authorized.

In addition to military labor costs, Reference 23c requires that a surcharge of 4% be added to material costs and a general and administrative surcharge of 3% be added to the total costs. This brings the total charges billable to non-Government users to $2,356,992. Dividing by 302,304 systems hours results in a rate of $7.80 per systems hour on the 6500's and $23.40 per systems hour on the 175.

4. Additional Charges for Intercom Use

The charges for batch processing discussed above reimburse FNOC for the use of its mainframe computer resources. When using the Intercom, or interactive mode, additional resources are consumed. The chargeable costs are for the lease of the telephone lines, some of the modems, and for maintenance of the modems and terminals (estimated to be 2% of the total manhours of the Maintenance Division). The total lease and maintenance costs total $9,514. Based upon Intercom usage for the past 12 months, usage is projected to be 1800 systems hours for the next year. Thus, a charge of $5.29 (9,514 ÷ 1800) should be added to the previously computed batch rates to recover costs for the additional Intercom resources.

5. Charges for Use of Input/Output Devices

The rates derived in the previous section do not recover costs for use of the various I/O devices. As in the current algorithm, these costs must be recovered by factors in addition to the systems hour. The rate used to charge for the use of a peripheral device is determined by dividing the chargeable costs of that device (lease costs and consumables) by an estimate of the usage of that device. For example, the cost per card punched was determined by adding the lease cost of the card punches ($16,200 per year) to the cost of IBM cards ($11.80 per case times 62 cases) and dividing the sum by the estimated

number of cards that will be punched (744,000). The result is a rate of $.023. Charges for the other I/O devices were derived in a similar fashion.

The complete proposed algorithm is shown in Appendix B. Note that charges for cards read, tapes mounted, and for differing priorities have been eliminated. The charge for cards read was eliminated because the card reader is owned by FNOC and the cards are not provided by FNOC; therefore, there are no reimbursable charges involved in card reading. In like manner, the charge for tape mounting has been eliminated because the recoverable costs - lease of tape drives, labor, and the cost of the tapes - have been included in the costs used to calculate the rate per systems hour and are therefore recovered by the systems hour charge. The charging factors for differing priorities were eliminated because they are not currently authorized.

D. STRENGTHS AND WEAKNESSES OF THE PROPOSED ALGORITHM

Relative to the present algorithm, the proposed algorithm offers some improvements. Chief among these is that the proposed algorithm has excluded non-allowable costs from consideration in determining user charges. It also eliminates the unauthorized charges for differing priorities. The proposed algorithm contains fewer charging factors, which should make it somewhat easier for users to understand. The less complicated algorithm also will reduce the amount of time necessary to make out the customers' bills, which is done manually. The suggested algorithm shares many of the current algorithm's strong points: they both produce rates which are stable, equitable, and consistent.

Although the proposed algorithm introduces no weaknesses which were not present in the current algorithm, it has not eliminated several of the present algorithm's weak points. The proposed algorithm maintains a composite charging

unit, which some ADP professionals do not favor. Because of Navy regulations, a flexible pricing system cannot be used; therefore, resource allocation and utilization by the suggested algorithm are not as efficient as they might be under a flexible pricing system. Finally, with rates ranging from $4 to $28.69 per systems hour, it is doubtful that the "economically significant" rates recommended by the Navy Audit Service [30:13] have been established. The rates would be higher if FNOC used more civilian operators and especially if it were to lease rather than buy its equipment. Such decisions are made for reasons other than recovery of the computer center's operation costs, however.

VI. POTENTIAL FUTURE DEVELOPMENTS

The Department of the Navy's (DON) guidelines concerning ADP charge back systems were discussed in Chapter IV. However, the DON is not free to make unilateral policy decisions. It must conform to policy issued by the Department of Defense (DOD) and by other Executive Department agencies, especially to directives issued by the Office of Management and Budget (OMB). The Congress has significant influence upon the DON through the budgetary process and through its investigatory arm, the General Accounting Office (GAO). The GAO was also given by the Budget and Accounting Procedures Act of 1950 the responsibility to ensure that the accounting and internal control systems of each executive agency:

> ...conform to the accounting principles, standards, and related requirements prescribed by the Comptroller General of the United States in accordance with that law. [21:2-1]

A. ADP COSTING SYSTEMS: THE GAO VIEWPOINT

The General Accounting Office feels that "cost accounting should be an integral part of an agency's management control and accounting systems." [20:2] This cost accounting system should identify and report ADP costs quickly and economically. Such cost information should enable agency managers to:

1) Compare costs among organizations, activities, operations, and projects;

2) Make informed investment decisions by facilitating (a) estimates of the cost of implementing proposals for new systems and facilities, (b) preparation of cost-benefit analyses, and (c) cost comparisons with commercial and other alternatives;

3) Establish the cost of work done and measure productivity;

4) Measure the cost of performance of responsible officials;

5) Make end users and top management conscious of the cost of data processing systems and services;

6) Provide the accounting basis for proper charging of appropriation, allotment, and program accounts, as well as the billing for certain intra- and inter-agency services; and

7) Provide the accounting basis for budget justifications and reports to the Congress, OMB, GSA, and the public on the cost, custody, and use of the automatic data processing resources entrusted to them. [20:2-3]

What are the costs of providing ADP services that should be identified and reported? The GAO guidelines are all-encompassing. The categories of cost which it feels constitute "full costs" are:

1) Personnel. Salaries and fringe benefits for civilian and military personnel who perform and manage ADP functions; ADP-related custodial services, security, building maintenance, and contract management.

2) Equipment. Nonrecurring expenditures for acquisition and recurring costs for rental, leasing, and depreciation of computers and associated online and offline ADP equipment.[1]

3) Computer Software. Nonrecurring expenditures for acquisition, and conversion and recurring expenses for rental, leasing, and depreciation of all types of software -- operating, multipurpose, and application.

4) Space Occupancy. Funded and unfunded costs for (a) rental, lease, and depreciation of buildings and general office furniture, (b) building maintenance, (c) regular telephone service and utilities, and (d) custodial services and security.

5) Supplies. Expenditures for noncapital office supplies and general- and special-purpose data processing materials.

6) Intra-agency Services and Overhead. The costs of normal agency support services and overhead, either billed or allocated, and the costs of central management, policy, and procurement services.

7) Contracted Services. Any of the above services if procured contractually. [28:5]

The GAO feels, then, that all direct and indirect costs associated with operation of an ADP facility should be identified and reported. Its approach

[1]The phrases "nonrecurring expenditure" and "recurring costs for...depreciation" seem to imply double counting of equipment costs. The author believes that "nonrecurring expenditures" relates to noncapitalized equipment, while "depreciation" relates to capitalized equipment.

is similar to that taken by divisions of many large corporations; even such "corporate" overhead expenses as "normal agency support services" (i.e., personnel, procurement, payroll) and "central ADP management" should be billed or allocated to the ADP function. It feels that failing to provide agency management with full costs results in "imprudent decisions." [20:13] Some of these imprudent decisions include not choosing the least expensive method of procuring ADP services, continuing projects which should have been terminated, not encouraging cost consciousness in users, and not eliminating submarginal uses of data processing resources and services.

Many of the imprudent decisions noted by GAO are also arguments in favor of ADP charge back systems presented in Chapter III. GAO firmly believes that users should be made aware of the costs of ADP services which they consume. In fact, that should be a primary objective of the cost accounting system, for

> By fully accounting for data processing costs, agencies can inform users of the costs of services furnished to them. Thus, made conscious of costs, users can determine whether work done by the computer is worth the cost and they can estimate the cost of any new requirements. [20:15]

However, GAO is not nearly as unequivocal as to whether charges should be billed, as opposed to reported, to users. In Reference 28, GAO states:

> ...we recommend that costs be assigned to benefiting user applications even if costs are not formally billed to individual users. [28:23]

But in Reference 20, it says:

> The full cost of providing data processing services should be aggregated and billed to the using organization's account(s) whenever such services are provided to
>
> --other agencies,
>
> --programs and organizations financed by other budgetary or appropriation accounts, or
>
> --other major organizational elements within an agency [20:21]

Considering the two references together, GAO seems to be implying that the DON should charge for ADP services if the customer were outside the DOD ("other agencies") or in another service ("other major organizational elements within an agency"), but that charging customers within the DON is optional.

B. ADP COSTING SYSTEMS: THE OMB VIEWPOINT

If the intent of the GAO references quoted above were to be implemented within the DON, it would cause drastic changes in Navy accounting procedures. For instance, depreciation records would have to be maintained for ADP equipment and for buildings, utility charges would have to be allocated, software amortized, and the costs of functional managers on headquarters staffs distributed among field activities. Such major policy changes usually take quite some time to be implemented at the operational level. The first step, however, seems to have been taken in April 1979, when the Office of Management and Budget issued a Draft Circular and requested comments from Executive Department Agencies.

The purpose of the Circular is to establish policies "requiring" Federal agencies to, among other things:

> ...(a) account for the full cost of operating multi-user, general management data processing facilities, and (b) recover the costs by charging user organizations for the services provided. [22:1]

The influence of GAO on the Circular is unmistakable. The items to be included in the "full costs" of operating an ADP facility are the same as those listed above; in fact, the wording in several instances is identical. OMB is more specific than GAO in giving its opinion on charging users. It states that agencies "...shall share their data processing facilities..." and that the providing organization shall obtain "...reimbursement for the full costs of providing services." [22:3]

In an undated memorandum to the Assistant Secretary of Defense (Comptroller), the Assistant Secretary of the Navy (Financial Management) (ASN(FM)) took exception to the draft OMB Circular on the subject of depreciation, stating:

> Until a real purpose is identified for utilization of ADP depreciation cost in the federal sector, the cost of maintaining depreciation schedules on all capitalized equipment and facilities appears strongly to outweigh any benefit to be derived.

More importantly, however, the ASN(FM) stated "Navy concurs generally with the concepts contained in the OMB Circular." From the above discussion, it is apparent that the impetus in the future within the Federal government, from both the Legislative and Executive Branches, will be towards ADP charge back policies which are more in keeping with those of commercial service bureaus than those which are currently promulgated by the DON.

VII. SUMMARY AND CONCLUSIONS

The literature in the field of automatic data processing overwhelmingly supports the use of a charge back system to bill users for the cost of the computer resources that they utilize. A charge back system which employs flexible prices is most widely recommended. By using flexible prices, which base charges on the economic value of the services provided, in addition to the cost of providing them, an organization can attain all three goals of charging for ADP services: cost recovery, resource allocation, and resource utilization. The most common type of ADP charge back system, however, is the average cost system. Under this method, estimated costs of operating the computer facility are divided by the estimated usage of each resource to produce an average, or standard, rate. Average cost charge back systems are relatively ineffective in attaining the goals of resource allocation and resource utilization.

Despite the advantages of flexible price charge back systems, current Navy guidelines require the use of average cost systems. Cost which may be billed to and recovered from government users are limited to the direct cost of operating the computer facility. These direct costs include civilian labor, maintenance and lease of computer equipment, and consumables. Excluded are utilities, depreciation of equipment, building occupancy and maintenance costs, military salaries, and general and administrative costs. Additional reimbursables from non-government users include military labor and surcharges to recover benefit contributions and depreciation.

Fleet Numerical Oceanography Center currently has in operation an equitable and well-accepted average cost charge back system. New rates were determined

in the thesis by applying the Navy guidelines to estimates of cost and usage for the next twelve months. These new rates are considerably lower than those charged by commercial service bureaus. This disparity is caused both by current Navy guidelines and by the facts that FNOC owns most of its equipment and utilizes primarily military operators.

The General Accounting Office and the Office of Management and Budget hold broader viewpoints of what costs should be reimbursed by users of ADP services than those promulgated by Navy guidelines. Should the GAO and OMB viewpoints be incorporated into DON policy, Navy accounting procedures would have to be altered considerably.

APPENDIX A

CURRENT CHARGING ALGORITHM FOR FNOC ADP SERVICES

INTERCOM USAGE

COST ($) = (X*SH) + (A*LP) + (B*VI) + (C*CR) + (D*CP) + ((E*TM)+1.) + (F*FI) + (L*CT)

BATCH USAGE

COST ($) = (Y*P*SH) + (A*LP) + (B*VI) + (C*CR) + (D*CP) + ((E*TM)+1.) + (F*FI)

A = $.00015/Line

B = $.003/Inch

C = $.005/Card

D = $.010/Card

E = $1.0/Tape

F = $0.25/Fiche

L = Access Level Factor

L = (1 + (Access Level - 1.0)*.1)

P = Priority Factor

P = (1 + (JOB CARD PRIORITY - 1.0)*.1)

X - COST PER SYSTEMS HOUR FOR INTERCOM

X = $50 for CDC 6500 usage - Fair Share
$5 for CDC 6500 usage - Preferred Rate
$500 for CDC 6500 usage - Non-government

X = $150 for CDC CYBER 175 usage - Fair Share
$15 for CDC CYBER 175 usage - Preferred Rate
$1,500 for CDC CYBER 175 usage - Non-government

Y - COST PER SYSTEMS HOUR FOR BATCH

Y = $30 for CDC 6500 usage - Fair Share
$3 for CDC 6500 usage - Preferred Rate
$300 for CDC 6500 usage - Non-government

Y = $90 for CDC CYBER 175 usage - Fair Share
$9 for CDC CYBER 175 usage - Preferred Rate
$900 for CDC CYBER 175 usage - Non-Government

CP - NUMBER OF CARDS PUNCHED

CR - NUMBER OF CARDS READ

CT - CONNECT TIME IN MINUTES

FI - NUMBER OF MICROGICHE PRINTED

LP - NUMBER OF LINES PRINTED

SH - SYSTEMS HOURS AS DEFINED IN NOS/BE INSTALLATION MANUAL

TM - NUMBER OF TAPES MOUNTED

VI - NUMBER OF INCHES PLOTTED BY THE ELECTROSTATIC PLOTTER

APPENDIX B

PROPOSED CHARGING ALGORITHM FOR FNOC ADP SERVICES

INTERCOM USAGE

COST ($) = (X*SH) + (A*LP) + (B*VI) + (C*CP) + (D*FI)

BATCH USAGE

COST ($) = (Y*SH) + (A*LP) + (B*VI) + (C*CP) + (D*FI)

A = $.00012/Line

B = $.047/Inch

C = $.023/Card

D = $1.06/Fiche

X - COST PER SYSTEMS HOUR FOR INTERCOM

X = $9.29 for CDC 6500 usage - Government users
$13.29 for CDC 6500 usage - Non-government users

X = $17.29 for CDC 175 usage - Government users
$28.69 for CDC 175 usage - Non-government users

Y - COST PER SYSTEMS HOUR FOR BATCH

Y = $4 for CDC 6500 usage - Government users
$7.80 for CDC 6500 usage - Non-government users

Y = $12 for CDC 175 usage - Government users
$23.40 for CDC 175 usage - Non-Government users

CP - NUMBER OF CARDS PUNCHED

FI - NUMBER OF MICROFICHE PRINTED

SH - SYSTEMS HOUR

VI - NUMBER OF INCHES PLOTTED BY THE ELECTROSTATIC PLOTTER

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